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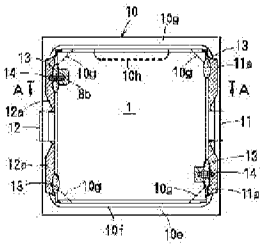
(54) **PIEZOELECTRIC ELECTROACOUSTIC TRANSDUCER**



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a piezoelectric electroacoustic transducer that has compatibility in downsizing and a low frequency configuration

and can stabilize the resonance frequency even when a bent or a swell exists in the diaphragm.

SOLUTION: In the piezoelectric electroacoustic transducer provided with a square piezoelectric diaphragm 1 that is subjected to bending vibration in a broadwise direction by applying an alternating signal between electrodes and with cases 10, 20 that contain the piezoelectric diaphragm 1, supports 10 g are provided to the cases 10, 20 to support four corners of the piezoelectric diaphragm 1.

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CLAIMS

[Claim(s)]

[Claim 1] The piezo-electric mold electroacoustic transducer characterized by forming the supporter which supports four corners of a piezo-electric diaphragm to the above-mentioned case in the thickness direction in the piezo-electric mold electroacoustic transducer equipped with the case which contains the piezo-electric diaphragm and the above-mentioned piezo-electric diaphragm of the square which carries out crookedness vibration by impressing an alternation signal to inter-electrode.

[Claim 2] The piezo-electric mold electroacoustic transducer according to claim 1 characterized by the internal connection section of a terminal electrode having been exposed near the supporter of the above-mentioned case, this internal connection section and the external connection through which it flows being exposed to the external surface of a case, and the internal connection section of the electrode of a piezo-electric diaphragm and a terminal electrode being electrically connected by electroconductive glue.

[Claim 3] The piezo-electric mold electroacoustic transducer according to claim 1 or 2 characterized by carrying out the closure of the clearance between the periphery section of the above-mentioned piezo-electric diaphragm, and the inner circumference section of a case with elastic encapsulant.

[Claim 4] The piezo-electric mold electroacoustic transducer according to claim 1 or 2 characterized by the thing of the above-mentioned piezo-electric diaphragm which the film is attached in the periphery section at least, and is done to the inner circumference section of a case for the closure of the clearance between a

piezo-electric diaphragm and a case joining or by pasting up in this film.
[Claim 5] The supporter formed in the above-mentioned case is a piezo-electric mold electroacoustic transducer according to claim 1 to 4 characterized by being the projection which carries out point support of near [four] the corner of a piezo-electric diaphragm.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to piezo-electric mold electroacoustic transducers, such as a piezo-electric buzzer and a piezo-electric earphone.
[0002]
[Description of the Prior Art] Conventionally, in electronic equipment, home electronics, a portable telephone, etc., the piezo-electric mold electroacoustic transducer is widely used as the piezo-electric buzzer which generates an alarm tone and a sound of operation, or a piezo-electric earphone. Its thing of the structure which closed opening of a case with covering is common while this kind

of piezo-electric mold electroacoustic transducer sticks a circular piezoelectric device on one side of a circular metal plate, constitutes a uni-morph mold diaphragm, and silicone rubber is used for it and it supports the periphery section of a metal plate in a circular case. However, when the circular diaphragm was used, there was a trouble that productive efficiency was bad and it was difficult for sound conversion efficiency to constitute low and small.

[0003] Then, the piezo-electric mold electroacoustic transducer which enabled improvement in productive efficiency, the improvement in sound conversion efficiency, and a miniaturization is proposed by using a square diaphragm (JP,2000-310990,A). This piezo-electric mold electroacoustic transducer has a square piezo-electric diaphragm, and the bottom wall section and the four side-attachment-wall sections. The insulating case where had the supporter which supports a diaphragm inside the two side-attachment-wall sections which counter, and the 1st and the 2nd current carrying part for external connection were prepared in the supporter, While two sides and supporter with which it has the cover plate which has a sound emission hole, a diaphragm is contained in a case, and a diaphragm counters are fixed with adhesives or an elastic sealing agent The closure of the clearance between remaining two sides and cases of a diaphragm is carried out with an elastic sealing agent, a diaphragm and the 1st and 2nd current carrying part are electrically connected by electroconductive glue, and it has structure which the cover plate pasted up on the side-attachment-wall section opening edge of a case. Moreover, there is also the approach of fixing four sides of a diaphragm to the supporter of a case with adhesives or an elastic sealing agent as other fixed approaches of a piezo-electric diaphragm.

[0004]

[Problem(s) to be Solved by the Invention] With the manner of support, a piezo-electric diaphragm may carry out crookedness vibration in the case where crookedness vibration is carried out in die-length bending mode, and area crookedness mode. The former is the case where two sides of a diaphragm are fixed to a case, and is the mode which carries out crookedness vibration in the

thickness direction by using the die-length direction both ends as the supporting point. the case where the latter fixes four sides of a diaphragm to a case -- it is -- four sides -- the supporting point -- carrying out -- the intersection of the diagonal line of a diaphragm -- max -- a variation rate -- it is the mode in which the whole area of a diaphragm carries out crookedness vibration in the thickness direction so that it may become an amount.

[0005] However, also when carrying out crookedness vibration by any in the conventional die-length bending mode or area crookedness mode, there is a fault that the resonance frequency of a diaphragm is high and cannot raise sound pressure of a low frequency region. Although low-frequency-izing is possible if the dimension of a case and a diaphragm is enlarged, now, an electroacoustic transducer will be enlarged. Moreover, in the former, there was two sides or the problem that resonance frequency will not be stabilized if camber and a wave are in a diaphragm, since four sides are restrained strongly of a diaphragm.

[0006] Then, even if the purpose of this invention is compatible in a miniaturization and low frequency-ization and camber and a wave are in a diaphragm, it is to offer the piezo-electric mold electroacoustic transducer which can stabilize resonance frequency.

[0007]

[Means for Solving the Problem] Invention which relates to claim 1 in order to attain the above-mentioned purpose offers the piezo-electric mold electroacoustic transducer characterized by forming the supporter which supports four corners of a piezo-electric diaphragm to the above-mentioned case in the piezo-electric mold electroacoustic transducer equipped with the case which contains the piezo-electric diaphragm and the above-mentioned piezo-electric diaphragm of the square which carries out crookedness vibration in the thickness direction by impressing an alternation signal to inter-electrode.

[0008] Also when supporting four sides of a diaphragm to a case like before, and also when supporting four corners of a diaphragm like this invention, both diaphragms vibrate in area crookedness mode, but as shown in drawing 1 , the

knots of vibration differ. That is, if four corners of a diaphragm are supported to vibrating considering the circle inscribed in a diaphragm as shown in (a) of drawing 1 as a knot if four sides of a diaphragm are supported, it will vibrate considering the circle mostly circumscribed to a diaphragm as shown in (b) of drawing 1 as a knot. Therefore, compared with the former, latter one of the maximum serious grade in the core of a circle is large, and its sound pressure is large. Moreover, since the displacement area of a diaphragm is [latter one] large compared with the former, the frequency of latter one's vibration becomes low and a dimension can realize a low frequency also with the same diaphragm. Also in the comparison with the case where two sides of a diaphragm are supported, although drawing 1 is the comparison with the case where the case where four sides of a diaphragm are supported, and a corner are supported, since the restraint to a diaphragm becomes small in the supporting structure of this invention, it can realize a low frequency and, moreover, can raise the sound pressure in a low frequency region. Since a diaphragm can deform freely by supporting four corners of a diaphragm as mentioned above while a miniaturization and low frequency-ization are realizable, even if camber and a wave are in a diaphragm, dispersion in resonance frequency can be controlled.

[0009] Like claim 2, the internal connection section of a terminal electrode is exposed near the supporter of a case, and this internal connection section and the external connection through which it flows are exposed to the external surface of a case, and may connect electrically the internal connection section of the electrode of a diaphragm, and a terminal electrode with electroconductive glue. That is, although it is necessary to impress an alternation signal to inter-electrode [of a diaphragm] in order to carry out crookedness vibration of the diaphragm in area crookedness mode, an alternation signal can be impressed by connecting the internal connection section of a terminal electrode and the electrode of a diaphragm which were exposed near the supporter of a case with electroconductive glue, without restraining vibration of a diaphragm as much as possible. In addition, since it has elasticity in the state of hardening when the

conductive paste of for example, an urethane system is used as electroconductive glue, the restraint of a diaphragm is small and ends.

[0010] Like claim 3, it is good to close the clearance between the periphery section of a diaphragm, and the inner circumference section of a case with elastic encapsulant. Even if a diaphragm carries out crookedness vibration in area crookedness mode, if a clearance is between a diaphragm and a case, a lifting and sound pressure will not be obtained in an air leak. If the clearance between the periphery section of a diaphragm and the inner circumference section of a case is closed with elastic encapsulant, an air leak can be lost without checking vibration of a diaphragm. As elastic encapsulant, silicone system adhesives can be used, for example.

[0011] Like claim 4, even if there is little diaphragm, the film is attached in the periphery section and the clearance between a diaphragm and a case may be closed for this film joining or by pasting up in the inner circumference section of a case. Although the clearance between a diaphragm and a case can be closed by applying elastic encapsulant like claim 3, vibration may be dumped if elastic encapsulant adheres to the clearance between a diaphragm and a case by the thickness beyond the need. On the other hand, if a diaphragm and a case are connected with a thin film, a diaphragm tends to vibrate and high sound pressure can be obtained. The film may be attached only in the periphery of a diaphragm and may be attached all over the diaphragm.

[0012] It is good also as a projection which carries out point support of near [four] the corner of a diaphragm for the supporter formed in the case like claim 5. That is, although a supporter may be formed in Taira and others and four corners of a diaphragm may be supported in a field, the contact surface of a diaphragm and a supporter may become large and may dump vibration. On the other hand, it stops almost restraining a supporter and a sound pressure property improves the letter of a projection, then a diaphragm in it. In that case, if the projection which counters the vertical section of a case is prepared and the corner of a diaphragm is pinched from the upper and lower sides among these projections,

while it will become unnecessary to fix with adhesives etc. and an activity will become easy, a back-face product becomes still smaller and does not dump vibration.

[0013]

[Embodiment of the Invention] Drawing 2 - drawing 6 show the piezo-electric mold electroacoustic transducer of the surface mount mold which is the 1st operation gestalt of this invention. The electroacoustic transducer of this operation gestalt fitted the application corresponding to the frequency of a large range like a piezo-electric earphone, and is equipped with the piezo-electric diaphragm 1, the case 10, and cover plate 20 of a laminated structure. Here, a case consists of a case 10 and a cover plate 20.

[0014] As shown in drawing 5 and drawing 6 , as for a diaphragm 1, the laminating of the two-layer electrostrictive ceramics layers 1a and 1b is carried out, the principal plane electrodes 2 and 3 are formed in the front flesh-side principal plane of a diaphragm 1, and the internal electrode 4 is formed among the ceramic layers 1a and 1b. As a thick wire arrow head shows, in the thickness direction, polarization of the two ceramic layers 1a and 1b is carried out in the same direction. The principal plane electrode 2 on a side front and the principal plane electrode 3 on a background are formed a little shorter than the side length of a diaphragm 1, and the end is connected to the end-face electrode 5 formed in one end face of a diaphragm 1. Therefore, the principal plane electrodes 2 and 3 of a front flesh side are connected mutually. The internal electrode 4 was mostly formed in the symmetry configuration with the principal plane electrodes 2 and 3, it is separated from the end of an internal electrode 4 of the internal electrode with the above-mentioned end-face electrode 5, and the other end is connected to the end-face electrode 6 formed in the other end side of a diaphragm 1. In addition, the end-face electrode 6 and the flowing narrow width auxiliary electrode 7 are formed in the front rear face of the other end of a diaphragm 1.

[0015] The wrap resin layers 8 and 9 are formed in the front rear face of a diaphragm 1 in the principal plane electrodes 2 and 3. These resin layers 8 and 9

are formed in order to prevent the crack of the diaphragm 1 by the fall impact. And the notches 8a and 9a which the principal plane electrodes 2 and 3 expose near the corner of the vertical angle of a diaphragm 1, and the notches 8b and 9b which an auxiliary electrode 7 exposes are formed in the resin layers 8 and 9 of a front flesh side. In addition, although Notches 8a, 8b, 9a, and 9b may be formed only in front flesh-side one side, in order to abolish the directivity of a front flesh side, in this example, it has prepared in the front rear face. Moreover, it is not necessary to use an auxiliary electrode 7 as the band electrode of constant width, and only the part corresponding to Notches 8b and 9b may be established. Here, the 10mmx10mmx20micrometer PZT system ceramics was used as ceramic layers 1a and 1b, and the polyamidoimide system resin whose thickness is 5-10 micrometers as resin layers 8 and 9 was used.

[0016] The case 10 is formed in the core box of four square shapes which have bottom wall section 10a and the four side-attachment-wall sections 10b-10e with insulating ingredients, such as ceramics or resin. When it constitutes a case 10 from resin, heat-resistant resin, such as LCP (liquid crystal polymer), SPS (syndiotactic polystyrene), PPS (polyphenylene sulfide), and epoxy, is desirable. 10f of annular level difference sections was prepared in the inner circumference of the four side-attachment-wall sections 10b-10e, and the internal connection sections 11a and 12a of the terminals 11 and 12 of a pair are exposed on 10f of level difference sections of the inside which are the two side-attachment-wall sections 10b and 10d which counter. Insert molding of the terminals 11 and 12 is carried out to a case 10, and the external connections 11b and 12b projected to the exterior of a case 10 are bent to the base side of a case 10 along the external surface which is the side-attachment-wall sections 10b and 10d. this example -- the internal connection sections 11a and 12a of terminals 11 and 12 -- two forks -- a ** -- separating -- **** -- these two forks -- the internal connection sections 11a and 12a of a ** are located near the corner section of a case 10.

[0017] It is the inside of 10f of level difference sections, and as shown in drawing 3 and drawing 4 , 10g of supporters for supporting four corners of a diaphragm 1

is formed in the four corner sections lower one step than 10f of level difference sections. Therefore, if a diaphragm 1 is laid on 10g of supporters, the top panel of a diaphragm 1 and the top face of the internal connection sections 11a and 12a of terminals 11 and 12 will become the same height mostly. Here, 10g of supporters is plane view 3 square shape-like, and 10g of four supporters is located in a line on the same periphery. In addition, 10h of 1st sound emission hole is formed in bottom wall section 10a.

[0018] A diaphragm 1 is contained by the case 10 and fixed to 10g of supporter of a case 10, and its near by the elastic support agent 13 by four places. That is, the elastic support agent 13 is applied between the principal plane electrodes 2 and internal connection section 11a of a terminal 11 which are exposed to notch 8a in a diagonal location, and between the auxiliary electrodes 7 and internal connection section 12a of a terminal 12 which are exposed to notch 8b. Moreover, the elastic support agent 13 is applied about two in the remaining diagonal location. In addition, although the elastic support agent 13 was applied to the oblong ellipse form here, a spreading configuration is not restricted to an ellipse form. As an elastic support agent 13, the urethane system adhesives of 3.7x106 Pa are used, for example for the Young's modulus after hardening. Moreover, since the viscosity in the condition of this elastic support agent 13 of not hardening has the property which cannot permeate easily highly (for example, 50 - 120 dPa-s), when it applies the elastic support agent 13, there is no possibility that the elastic support agent 13 may flow and fall to bottom wall section 10a through the clearance between a diaphragm 1 and a case 10. Heat hardening is carried out after applying the elastic support agent 13. In addition, as the fixed approach of a diaphragm 1, after containing a diaphragm 1 in a case 10, the elastic support agent 13 may be applied by a dispenser etc., but where the elastic support agent 13 is beforehand applied to a diaphragm 1, a diaphragm 1 may be held in a case 10.

[0019] The spreading location of the elastic support agent 13 is good to consider as the location near 10g of supporters as much as possible. Although the elastic

support agent 13 is applied to the location which shifted a little from 10g of supporters in drawing 3 , this is for electroconductive glue 14 to straddle the elastic support agent 13 top, and when the electrode and the internal connection sections 11a and 12a of a diaphragm 1 can be arranged in the corner section of a case 10, it can also use the spreading location of the elastic support agent 13 as 10g of supporters.

[0020] After stiffening the elastic support agent 13, it applies to an ellipse form so that the elastic support agent 13 top to which electroconductive glue 14 was applied by the ellipse form may be crossed, and the principal plane electrode 2, internal connection section 11a of a terminal 11 and an auxiliary electrode 7, and internal connection section 12a of a terminal 12 are connected, respectively. As electroconductive glue 14, the urethane system conductive paste of 0.3x109 Pa is used, for example for the Young's modulus after hardening. After applying electroconductive glue 14, heat hardening of this is carried out. The spreading configuration of electroconductive glue 14 is not restricted to an ellipse form, and just connects the principal plane electrode 2, internal connection section 11a and an auxiliary electrode 7, and internal connection section 12a ranging over the elastic support agent 13.

[0021] After applying and stiffening electroconductive glue 14, the elastic encapsulant 15 is applied to the clearance between the perimeter perimeter of a diaphragm 1, and the inner circumference section of a case 10, and the air leak between the side front of a diaphragm 1 and a background is prevented. Heat hardening is carried out after applying the elastic encapsulant 15 annularly. As elastic encapsulant 15, the silicone system adhesives of 3.0x105 Pa are used, for example for the Young's modulus after hardening.

[0022] After fixing a diaphragm 1 to a case 10 as mentioned above, a cover plate 20 pastes top-face opening of a case 10 with adhesives 21. A cover plate 20 is formed with the same ingredient as a case 10. By pasting up a cover plate 20, sound space is formed between a cover plate 20 and a diaphragm 1. The 2nd sound emission hole 22 is formed in the cover plate 20. The piezo-electric mold

electroacoustic transducer of a surface mount mold is completed as mentioned above.

[0023] At the electroacoustic transducer of this operation gestalt, crookedness vibration of the diaphragm 1 can be carried out in area crookedness mode by impressing a predetermined alternation electrical potential difference between a terminal 11 and 12. Since the electrostrictive ceramics layer the direction of polarization and whose direction of electric field are the same directions is shrunken in the direction of a flat surface and the electrostrictive ceramics layer the direction of polarization and whose direction of electric field are hard flow is extended in the direction of a flat surface, it is crooked in the thickness direction as a whole. With this operation gestalt, a diaphragm 1 is the laminating structure of the ceramics, and since two oscillating fields (ceramic layer) arranged in order in the thickness direction vibrate to hard flow mutually, compared with a uni-morph mold diaphragm, the big amount of displacement, i.e., big sound pressure, can be obtained.

[0024] Drawing 7 shows the sound pressure property of the case where two sides which the piezo-electric diaphragm 1 counters are supported in a case, and the case where four corners are supported in a case. It turns out that the latter resonance frequency is near 800Hz, resonance frequency fell by supporting by four corners to the former resonance frequency being near 1200Hz, and the sound pressure in resonance frequency moreover rose so that clearly from drawing.

[0025] Drawing 8 - drawing 10 show the 2nd operation gestalt of the piezo-electric mold electroacoustic transducer concerning this invention. With this operation gestalt, while preparing plinth section 10i in the four corner sections of a case 10, projection 10j is protruded on the top face of this plinth section 10i, and point support of the inferior surface of tongue of the corner of a diaphragm 1 is mostly carried out by this projection 10j. In this case, since the contact surface of a diaphragm 1 and projection 10j becomes very small and does not dump vibration, there is an advantage that a sound pressure property improves. In

addition, in drawing 10 , illustration of 10f of level difference sections inside side attachment walls 10c and 10e was omitted.

[0026] In the 2nd operation gestalt, projection 10j of a case 10 and the projection which counters may be prepared in the inferior surface of tongue of a cover plate 20, and a diaphragm 1 may be pinched from the upper and lower sides among these projections.

[0027] Drawing 11 and drawing 12 show the 3rd operation gestalt of the piezo-electric mold electroacoustic transducer concerning this invention. With this operation gestalt, while preparing level difference section 10k in the inside perimeter of a case 10, 10l. of supporters jutted out inside is formed in the four corner sections of level difference section 10k. Level difference section 10k and 10l. of supporters are formed in the same height. The diaphragm 1 is pasted up on the film 30 more large-sized than this diaphragm 1. As for the diaphragm 1, four corners are formed in the magnitude in which four sides do not appear on level difference section 10k by appearing in 10l. of supporters. a film 30 has the elasticity of polyimide etc. -- thin -- it is a **** film and what does not check crookedness vibration of a diaphragm 1 is used. The perimeter of a film 30 is pasted up or welded at level difference section 10k of a case 10, and 10l. of supporters.

[0028] In this case, since it has the role which a film 30 fixes a diaphragm 1 to a case 10, and closes the clearance between cases 10, it is possible to omit the elastic support agent 13 and the elastic encapsulant 15. Moreover, there are also no worries about oscillating damping of the diaphragm 1 by applying the elastic encapsulant 15 beyond the need. In addition, the thing of the shape of a frame pasted up only on the periphery of not only a 4 square-shape-like thing but the diaphragm 1 pasted up all over the diaphragm 1 is sufficient as a film 30. Moreover, a film may be pasted up on the inferior surface of tongue, top face, or vertical both sides of a diaphragm 1.

[0029] In order to support four corners of a diaphragm 1 to stability more in the case of this operation gestalt, heights may be prepared in the inferior surface of

tongue of a cover plate 20, and the corner of a diaphragm 1 may be pressed to 10l. of supporters by these heights. Although illustration of the terminal prepared in a case 10 was omitted in drawing 11 and 12, it is the same as that of drawing 2 or drawing 10 almost. What is necessary is just to connect the internal connection section of a terminal, and the electrode of a diaphragm 1 with electroconductive glue also in this case.

[0030] This invention is not limited to the above-mentioned operation gestalt, and can be changed in the range which does not deviate from the meaning of this invention. Although the piezo-electric diaphragm of the above-mentioned operation gestalt carries out the laminating of the two-layer electrostrictive ceramics layer, what carried out the laminating of the three or more-layer electrostrictive ceramics layer may be used. Moreover, the diaphragm which stuck the piezo-electric plate on one side or both sides of not only the layered product of an electrostrictive ceramics layer but a metal plate may be used as a piezo-electric diaphragm. The terminal electrode in this invention may be an electrode of the thin film from the supporter top face of a case to [does not restrict to an insertion terminal like the above-mentioned operation gestalt, and] outside for example, or a thick film. The case of this invention contains a piezo-electric diaphragm, and does not restrict it to what consisted of a case of a concave cross-section configuration like an operation gestalt, and a cover plate adhered to the top face that what is necessary is just what has the function which supports four corners.

[0031]

[Effect of the Invention] If an alternation signal is impressed to inter-electrode [of a diaphragm] by the above explanation according to invention according to claim 1 since four corners of a diaphragm were supported in the case so that clearly, a diaphragm will carry out crookedness vibration in area crookedness mode by using the circumscribed circle as a knot mostly. Therefore, the displacement area of a diaphragm becomes large, the maximum serious grade in the core of a circle is large, and sound pressure is large. Moreover, the frequency of vibration

becomes low compared with the two-side supporting structure or the four-side supporting structure, and a dimension can realize a low frequency also with the same diaphragm. Furthermore, since a diaphragm can deform freely by supporting four corners of a diaphragm, even if camber and a wave are in a diaphragm, it has the effectiveness that resonance frequency is stabilized.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the comparison Fig. of the knot [support / four side support of a diaphragm, and / corner] of vibration.
[Drawing 2] It is the decomposition perspective view of the 1st operation gestalt of the piezo-electric mold electroacoustic transducer concerning this invention.
[Drawing 3] It is a top view in the condition of having excepted the cover plate and elastic encapsulant of a piezo-electric mold electroacoustic transducer which are shown in drawing 2 .
[Drawing 4] It is the A-A line sectional view of drawing 3 .
[Drawing 5] It is the perspective view of the piezo-electric diaphragm used for the piezo-electric mold electroacoustic transducer of drawing 2 .

[Drawing 6] It is a stairway sectional view by the B-B line of drawing 5 .

[Drawing 7] It is the sound pressure comparison Fig. of two-side support of a piezo-electric diaphragm, and corner support.

[Drawing 8] It is a top view in the condition of having excepted the cover plate and elastic encapsulant of the 2nd operation gestalt of a piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 9] It is the C-C line sectional view of drawing 8 .

[Drawing 10] It is the perspective view of the case used for the piezo-electric mold electroacoustic transducer of drawing 8 .

[Drawing 11] It is a perspective view in the condition of having excepted the cover plate of the 3rd operation gestalt of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 12] It is the decomposition perspective view of the case of drawing 11 , and a diaphragm.

[Description of Notations]

1 Piezo-electric Diaphragm

10 Case

10g Supporter

11 12 Terminal (terminal electrode)

11a, 12a Internal connection section

11b, 12b External connection

14 Electroconductive Glue

15 Elastic Encapsulant

20 Cover Plate

[Translation done.]

* NOTICES *

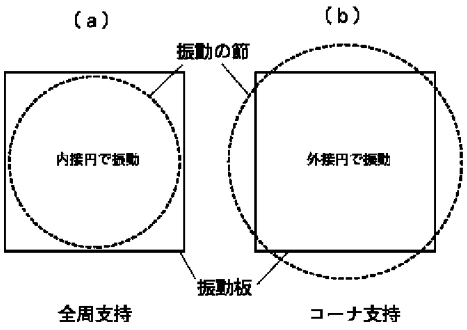
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

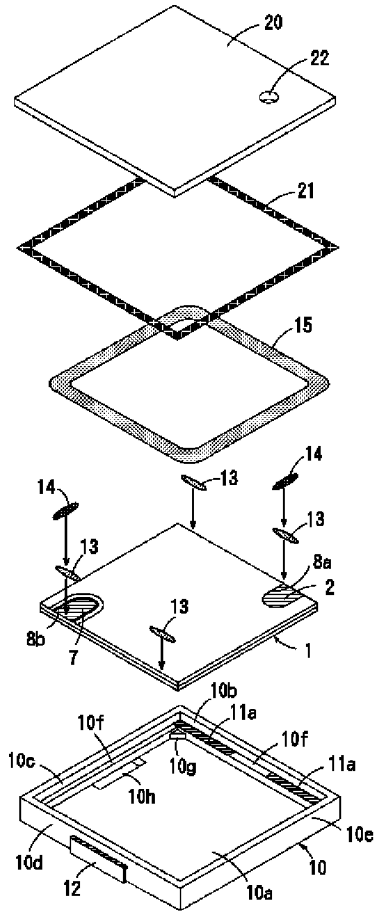
3.In the drawings, any words are not translated.

DRAWINGS

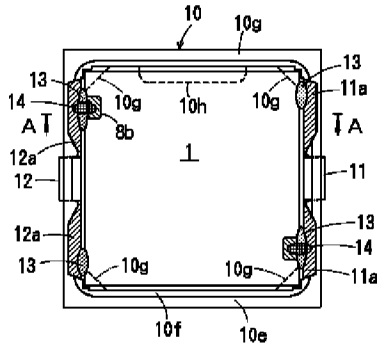
[Drawing 1]



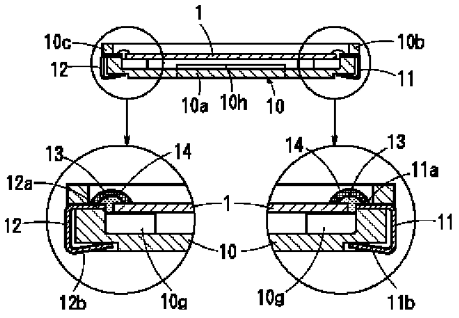
[Drawing 2]



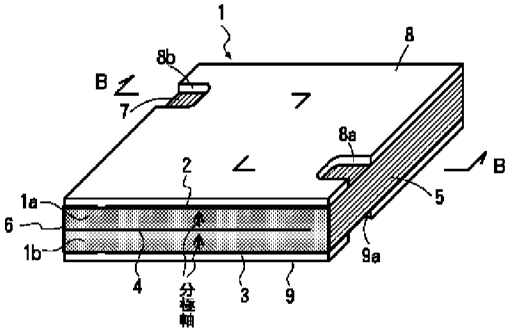
[Drawing 3]



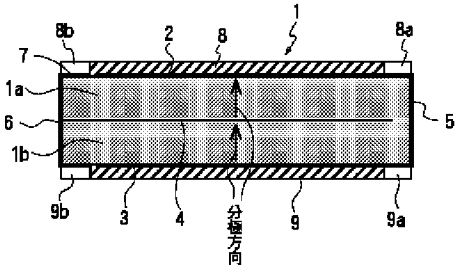
[Drawing 4]



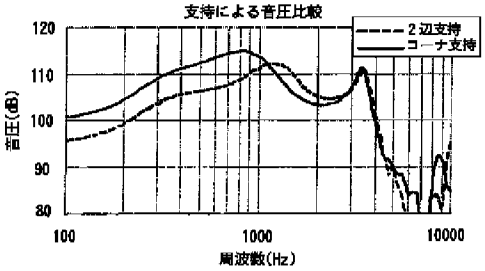
[Drawing 5]



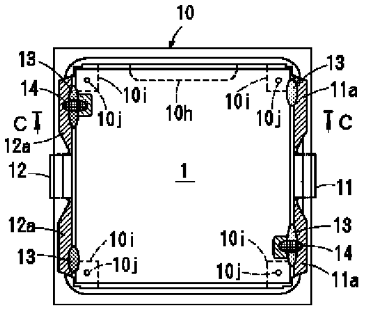
[Drawing 6]



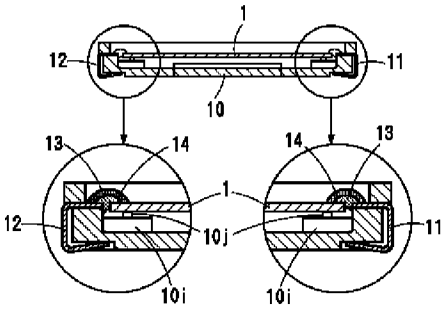
[Drawing 7]



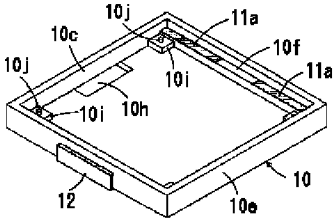
[Drawing 8]



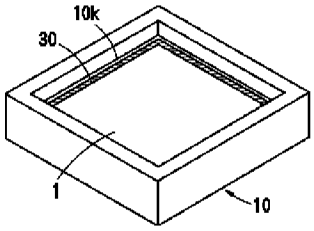
[Drawing 9]



[Drawing 10]



[Drawing 11]



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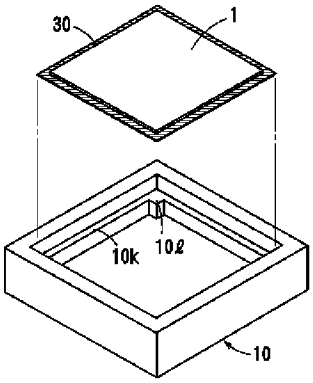

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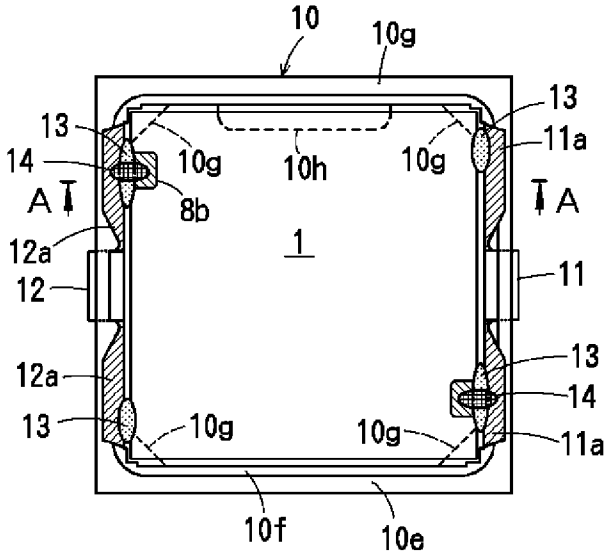
最終頁に続く

(54)【発明の名称】　圧電型電気音響変換器

(57)【要約】
【課題】小型化と低周波化とを両立でき、振動板にそりやうねりがあっても、共振周波数を安定させることができる圧電型電気音響変換器を提供する。
【解決手段】電極間に交番信号を印加することにより厚み方向に屈曲振動する四角形の圧電振動板１と、圧電振動板１を収納する筐体１０，２０とを備えた圧電型電気音響変換器において、筐体１０，２０に圧電振動板１の４つの角部を支持する支持部１０ｇを設けた。



【特許請求の範囲】
【請求項１】電極間に交番信号を印加することにより厚み方向に屈曲振動する四角形の圧電振動板と、上記圧電振動板を収納する筐体とを備えた圧電型電気音響変換器において、上記筐体に圧電振動板の４つの角部を支持する支持部を設けたことを特徴とする圧電型電気音響変換器。
【請求項２】上記筐体の支持部近傍に端子電極の内部接続部が露出し、この内部接続部と導通する外部接続部が筐体の外面に露出しており、圧電振動板の電極と端子電極の内部接続部とが導電性接着剤により電気的に接続されていることを特徴とする請求項１に記載の圧電型電気音響変換器。
【請求項３】上記圧電振動板の外周部と筐体の内周部との隙間が弾性封止剤で封止されていることを特徴とする請求項１または２に記載の圧電型電気音響変換器。
【請求項４】上記圧電振動板の少なくとも外周部にフィルムが取り付けられており、このフィルムを筐体の内周部に溶着または接着することにより、圧電振動板と筐体との隙間が封止されることを特徴とする請求項１または２に記載の圧電型電気音響変換器。
【請求項５】上記筐体に設けられた支持部は、圧電振動板の４つの角部近傍を点支持する突起であることを特徴とする請求項１ないし４のいずれかに記載の圧電型電気音響変換器。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は圧電ブザーや圧電受話器などの圧電型電気音響変換器に関するものである。
【０００２】
【従来の技術】従来、電子機器、家電製品、携帯電話機などにおいて、警報音や動作音を発生する圧電ブザーあるいは圧電受話器として圧電型電気音響変換器が広く用いられている。この種の圧電型電気音響変換器は、円形の金属板の片面に円形の圧電素子を貼り付けてユニモルフ型振動板を構成し、金属板の周縁部を円形のケースの中にシリコーンゴムを用いて支持するとともに、ケースの開口部をカバーで閉鎖した構造のものが一般的である。しかしながら、円形の振動板を用いると、生産効率が悪く、音響変換効率が低く、しかも小型に構成することが難しいという問題点があった。
【０００３】そこで、四角形の振動板を用いることで、生産効率の向上、音響変換効率の向上および小型化を可能とした圧電型電気音響変換器が提案されている（特開２０００－３１０９９０号）。この圧電型電気音響変換器は、四角形の圧電振動板と、底壁部と４つの側壁部とを有し、対向する２つの側壁部の内側に振動板を支持する支持部を持ち、支持部に外部接続用の第１と第２の導電部が設けられた絶縁性ケースと、放音孔を有する蓋板とを備え、ケース内に振動板が収納され、振動板の対向する２辺と支持部とが接着剤または弾性封止材で固定されるとともに、振動板の残りの２辺とケースとの隙間が弾性封止材で封止され、振動板と第１，第２の導電部とが導電性接着剤により電気的に接続され、ケースの側壁部開口端に蓋板が接着された構造となっている。また、圧電振動板の他の固定方法として、振動板の４辺をケースの支持部に接着剤または弾性封止材で固定する方法もある。
【０００４】
【発明が解決しようとする課題】圧電振動板はその支持方法により、長さベンディングモードで屈曲振動する場合と、面積屈曲モードで屈曲振動する場合とがある。前者は、振動板の２辺をケースに固定した場合であり、長さ方向両端部を支点として厚み方向に屈曲振動するモードである。後者は振動板の４辺をケースに固定した場合であり、４辺を支点として振動板の対角線の交点が最大変位量となるように振動板の面積全体が厚み方向に屈曲振動するモードである。
【０００５】ところが、従来の長さベンディングモードあるいは面積屈曲モードのいずれで屈曲振動する場合も、振動板の共振周波数が高く、低周波域の音圧を上げることができないという欠点がある。ケースおよび振動板の寸法を大きくすれば、低周波化が可能であるが、これでは電気音響変換器が大型化してしまう。また、従来では振動板の２辺または４辺を強く拘束するので、振動板にそりやうねりがあると、共振周波数が安定しないという問題があった。
【０００６】そこで、本発明の目的は、小型化と低周波化とを両立でき、振動板にそりやうねりがあっても、共振周波数を安定させることができる圧電型電気音響変換器を提供することにある。
【０００７】
【課題を解決するための手段】上記目的を達成するため、請求項１に係る発明は、電極間に交番信号を印加することにより厚み方向に屈曲振動する四角形の圧電振動板と、上記圧電振動板を収納する筐体とを備えた圧電型電気音響変換器において、上記筐体に圧電振動板の４つの角部を支持する支持部を設けたことを特徴とする圧電型電気音響変換器を提供する。
【０００８】従来のように振動板の４辺を筐体に支持するときも、本発明のように振動板の４つの角部を支持するときも、振動板は共に面積屈曲モードで振動するが、図１に示すように振動の節が異なる。すなわち、振動板の４辺を支持すると、図１の（ａ）のように振動板に内接する円を節として振動するのに対し、振動板の４つの角部を支持すると、図１の（ｂ）のように振動板にほぼ外接する円を節として振動する。そのため、円の中心における最大変位は、前者に比べて後者の方が大きく、音圧が大きい。また、前者に比べて後者の方が振動板の変位面積が大きいので、後者の方が振動の周波数が低くな

り、外形寸法が同一の振動板でも低い周波数を実現できる。図１は振動板の４辺を支持した場合と角部を支持した場合との比較であるが、振動板の２辺を支持した場合との比較においても、本発明の支持構造では振動板への拘束力が小さくなるので、低い周波数を実現でき、しかも低周波域での音圧を高めることができる。上記のように振動板の４つの角部を支持することで、小型化と低周波化とを実現できるとともに、振動板が自由に変形できるので、振動板にそりやうねりがあっても、共振周波数のばらつきを抑制できる。

【０００９】請求項２のように、筐体の支持部近傍に端子電極の内部接続部が露出し、この内部接続部と導通する外部接続部が筐体の外面に露出しており、振動板の電極と端子電極の内部接続部とを導電性接着剤により電気的に接続してもよい。すなわち、振動板を面積屈曲モードで屈曲振動させるために、振動板の電極間に交番信号を印加する必要があるが、筐体の支持部近傍に露出した端子電極の内部接続部と振動板の電極とを導電性接着剤で接続することで、振動板の振動をできるだけ拘束せずに交番信号を印加することができる。なお、導電性接着剤として例えばウレタン系の導電ペーストを用いると、硬化状態で弾性を持つので、振動板の拘束力が小さくて済む。

【００１０】請求項３のように、振動板の外周部と筐体の内周部との隙間を弾性封止剤で封止するのがよい。振動板が面積屈曲モードで屈曲振動しても、振動板と筐体との間に隙間があると、空気漏れを起こし、音圧が得られない。振動板の外周部と筐体の内周部との隙間を弾性封止剤で封止すれば、振動板の振動を阻害せずに空気漏れを無くすことができる。弾性封止剤としては、例えばシリコーン系接着剤を使用することができる。

【００１１】請求項４のように、振動板の少なくとも外周部にフィルムが取り付けられており、このフィルムを筐体の内周部に溶着または接着することにより、振動板と筐体との隙間を封止してもよい。請求項３のように弾性封止剤を塗布することで振動板と筐体との隙間を封止することができるが、振動板と筐体との隙間に必要以上の厚みで弾性封止剤が付着すると、振動をダンピングしてしまう可能性がある。これに対し、振動板と筐体とを薄いフィルムで連結すれば、振動板が振動しやすく、高い音圧を得ることができる。フィルムは振動板の周辺部のみに取り付けられていてもよいし、振動板の全面に取り付けられていてもよい。

【００１２】請求項５のように、筐体に設けられた支持部を、振動板の４つの角部近傍を点支持する突起としてもよい。すなわち、支持部を平らに形成し、振動板の４つの角部を面で支持してもよいが、振動板と支持部との接触面が大きくなり、振動をダンピングすることがある。これに対し、支持部を突起状とすれば、振動板を殆ど拘束しなくなり、音圧特性が向上する。その場合、筐体の上下部に対向する突起を設け、これら突起の間で振動板の角部を上下から挟持するようにすれば、接着剤などで固定する必要がなくなり、作業が簡単になるとともに、支持面積が一層小さくなり、振動をダンピングすることがない。

【００１３】

【発明の実施の形態】図２～図６は本発明の第１の実施形態である表面実装型の圧電型電気音響変換器を示す。この実施形態の電気音響変換器は、圧電受話器のように広いレンジの周波数に対応する用途に適したものであり、積層構造の圧電振動板１とケース１０と蓋板２０とを備えている。ここでは、ケース１０と蓋板２０とで筐体が構成される。

【００１４】振動板１は、図５，図６に示すように、２層の圧電セラミックス層１ａ，１ｂを積層したものであり、振動板１の表裏主面には主面電極２，３が形成され、セラミックス層１ａ，１ｂの間には内部電極４が形成されている。２つのセラミックス層１ａ，１ｂは、太線矢印で示すように厚み方向において同一方向に分極されている。表側の主面電極２と裏側の主面電極３は、振動板１の辺長よりやや短く形成され、その一端は振動板１の一方の端面に形成された端面電極５に接続されている。そのため、表裏の主面電極２，３は相互に接続されている。内部電極４は主面電極２，３とほぼ対称形状に形成され、内部電極４の一端は上記端面電極５と離れており、他端は振動板１の他端面に形成された端面電極６に接続されている。なお、振動板１の他端部の表裏面には、端面電極６と導通する細幅な補助電極７が形成されている。

【００１５】振動板１の表裏面には、主面電極２，３を覆う樹脂層８，９が形成されている。この樹脂層８，９は、落下衝撃による振動板１の割れを防止する目的で設けられている。そして、表裏の樹脂層８，９には、振動板１の対角の角部近傍に、主面電極２，３が露出する切欠部８ａ，９ａと、補助電極７が露出する切欠部８ｂ，９ｂとが形成されている。なお、切欠部８ａ，８ｂ，９ａ，９ｂは表裏一方にのみ設けてもよいが、表裏の方向性をなくすため、この例では表裏面に設けてある。また、補助電極７は、一定幅の帯状電極とする必要はなく、切欠部８ｂ，９ｂに対応する箇所のみ設けてもよい。ここでは、セラミックス層１ａ，１ｂとして１０ｍｍ×１０ｍｍ×２０μｍのＰＺＴ系セラミックスを使用し、樹脂層８，９として厚みが５～１０μｍのポリアミドイミド系樹脂を使用した。

【００１６】ケース１０はセラミックスまたは樹脂などの絶縁性材料で底壁部１０ａと４つの側壁部１０ｂ～１０ｅとを持つ４角形の箱型に形成されている。ケース１０を樹脂で構成する場合には、ＬＣＰ（液晶ポリマー），ＳＰＳ（シンジオタクチックポリスチレン），ＰＰＳ（ポリフェニレンサルファイド），エポキシなどの

耐熱樹脂が望ましい。４つの側壁部１０ｂ～１０ｅの内周には環状の段差部１０ｆが設けられ、対向する２つの側壁部１０ｂ，１０ｄの内側の段差部１０ｆ上に、一対の端子１１，１２の内部接続部１１ａ，１２ａが露出している。端子１１，１２はケース１０にインサート成形されたものであり、ケース１０の外部に突出した外部接続部１１ｂ，１２ｂが側壁部１０ｂ，１０ｄの外面に沿ってケース１０の底面側へ折り曲げられている。この実施例では、端子１１，１２の内部接続部１１ａ，１２ａが二股状に別れており、これら二股状の内部接続部１１ａ，１２ａがケース１０のコーナ部近傍に位置している。

【００１７】段差部１０ｆの内側であって、４つのコーナ部には、図３，図４に示すように、振動板１の４つの角部を支持するための支持部１０ｇが、段差部１０ｆより一段低く形成されている。そのため、支持部１０ｇ上に振動板１を載置すると、振動板１の天面と端子１１，１２の内部接続部１１ａ，１２ａの上面とがほぼ同一高さになる。ここでは、支持部１０ｇが平面視３角形状であり、４個の支持部１０ｇが同一円周上に並んでいる。なお、底壁部１０ａには第１の放音孔１０ｈが形成されている。

【００１８】振動板１はケース１０に収納され、４箇所で弾性支持剤１３によってケース１０の支持部１０ｇまたはその近傍に固定される。すなわち、対角位置にある切欠部８ａに露出する主面電極２と端子１１の内部接続部１１ａとの間、および切欠部８ｂに露出する補助電極７と端子１２の内部接続部１２ａとの間に、弾性支持剤１３が塗布される。また、残りの対角位置にある２箇所についても弾性支持剤１３が塗布される。なお、ここでは弾性支持剤１３を横長な楕円形に塗布したが、塗布形状は楕円形に限るものではない。弾性支持剤１３としては、例えば硬化後のヤング率が３．７×10^6 Ｐａのウレタン系接着剤が使用される。また、この弾性支持剤１３の未硬化状態での粘性が高く（例えば５０～１２０ｄＰａ・ｓ）、滲みにくい性質を有するので、弾性支持剤１３を塗布したとき、弾性支持剤１３が振動板１とケース１０との隙間を通って底壁部１０ａまで流れ落ちる恐れがない。弾性支持剤１３を塗布した後、加熱硬化させる。なお、振動板１の固定方法としては、振動板１をケース１０に収納した後でディスペンサなどで弾性支持剤１３を塗布してもよいが、振動板１に予め弾性支持剤１３を塗布した状態で振動板１をケース１０に収容してもよい。

【００１９】弾性支持剤１３の塗布位置は、できるだけ支持部１０ｇに近い位置とするのがよい。図３では弾性支持剤１３が支持部１０ｇよりややずれた位置に塗布されているが、これは弾性支持剤１３の上を導電性接着剤１４が跨ぐようにするためであり、振動板１の電極および内部接続部１１ａ，１２ａをケース１０のコーナ部に配置できる場合には、弾性支持剤１３の塗布位置も支持部１０ｇとすることができる。

【００２０】弾性支持剤１３を硬化させた後、導電性接着剤１４を楕円形に塗布された弾性支持剤１３の上を交差するように楕円形に塗布し、主面電極２と端子１１の内部接続部１１ａ、補助電極７と端子１２の内部接続部１２ａとをそれぞれ接続する。導電性接着剤１４としては、例えば硬化後のヤング率が０．３×10^9 Ｐａのウレタン系導電ペーストが使用される。導電性接着剤１４を塗布した後、これを加熱硬化させる。導電性接着剤１４の塗布形状は楕円形に限るものではなく、弾性支持剤１３を跨いで主面電極２と内部接続部１１ａ、補助電極７と内部接続部１２ａとを接続できればよい。

【００２１】導電性接着剤１４を塗布，硬化させた後、弾性封止剤１５を振動板１の周囲全周とケース１０の内周部との隙間に塗布し、振動板１の表側と裏側との間の空気漏れを防止する。弾性封止剤１５を環状に塗布した後、加熱硬化させる。弾性封止剤１５としては、例えば硬化後のヤング率が３．０×10^5 Ｐａのシリコーン系接着剤が使用される。

【００２２】上記のように振動板１をケース１０に固定した後、ケース１０の上面開口部に蓋板２０が接着剤２１によって接着される。蓋板２０はケース１０と同様な材料で形成される。蓋板２０を接着することで、蓋板２０と振動板１との間に音響空間が形成される。蓋板２０には、第２の放音孔２２が形成されている。上記のようにして表面実装型の圧電型電気音響変換器が完成する。

【００２３】この実施形態の電気音響変換器では、端子１１，１２間に所定の交番電圧を印加することで、振動板１を面積屈曲モードで屈曲振動させることができる。分極方向と電界方向とが同一方向である圧電セラミックス層は平面方向に縮み、分極方向と電界方向とが逆方向である圧電セラミックス層は平面方向に伸びるので、全体として厚み方向に屈曲する。この実施形態では、振動板１がセラミックスの積層構造体であり、厚み方向に順に配置された２つの振動領域（セラミックス層）が相互に逆方向に振動するので、ユニモルフ型振動板に比べて大きな変位量、つまり大きな音圧を得ることができる。

【００２４】図７は、圧電振動板１の対向する２辺をケースに支持した場合と、４つの角部をケースに支持した場合との音圧特性を示す。図から明らかなように、前者の共振周波数が１２００Ｈｚ付近にあるのに対し、後者の共振周波数は８００Ｈｚ付近にあり、４つの角部で支持することで共振周波数が低下し、しかも共振周波数における音圧が上昇したことがわかる。

【００２５】図８～図１０は本発明にかかる圧電型電気音響変換器の第２の実施形態を示す。この実施形態では、ケース１０の４つのコーナ部に台座部１０ｉを設けるとともに、この台座部１０ｉの上面に突起１０ｊを突設し、この突起１０ｊで振動板１の角部の下面をほぼ点

支持したものである。この場合には、振動板１と突起１０ｊとの接触面が非常に小さくなり、振動をダンピングしないので、音圧特性が向上するという利点がある。なお、図１０では、側壁１０ｃ，１０ｅの内側の段差部１０ｆの図示を省略した。

【００２６】第２の実施形態において、蓋板２０の下面にケース１０の突起１０ｊと対向する突起を設け、これら突起の間で振動板１を上下から挟持してもよい。

【００２７】図１１，図１２は本発明にかかる圧電型電気音響変換器の第３の実施形態を示す。この実施形態では、ケース１０の内側全周に段差部１０ｋを設けるとともに、段差部１０ｋの４つのコーナ部に内側に張り出した支持部１０１を設けたものである。段差部１０ｋと支持部１０１とは同一高さに形成されている。振動板１は、この振動板１より大形なフィルム３０の上に接着されている。振動板１は、４つの角部が支持部１０１に載り、４辺は段差部１０ｋ上に載らない大きさに形成されている。フィルム３０はポリイミドなどの弾性を持つ薄肉なフィルムであり、振動板１の屈曲振動を阻害しないものを使用する。フィルム３０の全周がケース１０の段差部１０ｋおよび支持部１０１に接着または溶着される。

【００２８】この場合には、フィルム３０が振動板１をケース１０に固定しかつケース１０との隙間を封止する役割を有するので、弾性支持剤１３や弾性封止剤１５を省略することが可能である。また、必要以上の弾性封止剤１５を塗布することによる振動板１の振動ダンピングの心配もない。なお、フィルム３０は振動板１の全面に接着された４角形状のものに限らず、例えば振動板１の周辺部のみに接着された枠状のものでもよい。また、フィルムは振動板１の下面のみに限らず、上面あるいは上下両面に接着してもよい。

【００２９】この実施形態の場合、振動板１の４つの角部をより安定に支持するために、蓋板２０の下面に凸部を設け、この凸部で振動板１の角部を支持部１０１に押圧してもよい。図１１，１２では、ケース１０に設けられる端子の図示を省略したが、図２あるいは図１０とほぼ同様である。この場合も、端子の内部接続部と振動板１の電極とを導電性接着剤により接続すればよい。

【００３０】本発明は上記実施形態に限定されるものではなく、本発明の趣旨を逸脱しない範囲で変更可能である。上記実施形態の圧電振動板は２層の圧電セラミックス層を積層したものであるが、３層以上の圧電セラミックス層を積層したものでもよい。また、圧電振動板として、圧電セラミックス層の積層体に限らず、金属板の片面または両面に圧電板を貼り付けた振動板を用いてもよい。本発明における端子電極とは、上記実施形態のようなインサート端子に限るものではなく、例えばケースの支持部上面から外部に至る薄膜あるいは厚膜の電極であってもよい。本発明の筐体は、圧電振動板を収納し、４つの角部を支持する機能を有するものであればよく、実施形態のような凹断面形状のケースと、その上面に接着される蓋板とで構成されたものに限らない。

【００３１】

【発明の効果】以上の説明で明らかなように、請求項１に記載の発明によれば、振動板の４つの角部をケースで支持したので、振動板の電極間に交番信号を印加すると、振動板はほぼその外接円を節として面積屈曲モードで屈曲振動する。そのため、振動板の変位面積が大きくなり、円の中心における最大変位が大きく、音圧が大きい。また、振動の周波数が２辺支持構造や４辺支持構造に比べて低くなり、外形寸法が同一の振動板でも低い周波数を実現できる。さらに、振動板の４つの角部を支持することで、振動板が自由に変形できるので、振動板にそりやうねりがあっても、共振周波数が安定するという効果を有する。

【図面の簡単な説明】

【図１】振動板の４辺支持とコーナ支持との振動の節の比較図である。

【図２】本発明に係る圧電型電気音響変換器の第１実施形態の分解斜視図である。

【図３】図２に示す圧電型電気音響変換器の蓋板および弾性封止剤を除外した状態の平面図である。

【図４】図３のＡ－Ａ線断面図である。

【図５】図２の圧電型電気音響変換器に用いられる圧電振動板の斜視図である。

【図６】図５のＢ－Ｂ線による階段断面図である。

【図７】圧電振動板の２辺支持とコーナ支持との音圧比較図である。

【図８】本発明に係る圧電型電気音響変換器の第２実施形態の蓋板および弾性封止剤を除外した状態の平面図である。

【図９】図８のＣ－Ｃ線断面図である。

【図１０】図８の圧電型電気音響変換器に用いられるケースの斜視図である。

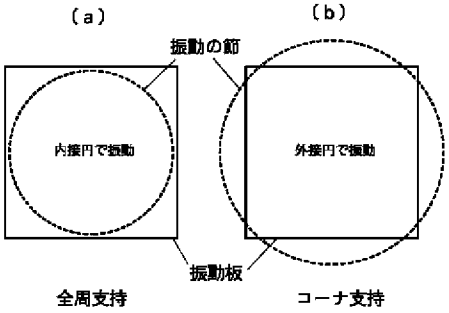
【図１１】本発明に係る圧電型電気音響変換器の第３実施形態の蓋板を除外した状態の斜視図である。

【図１２】図１１のケースと振動板との分解斜視図である。

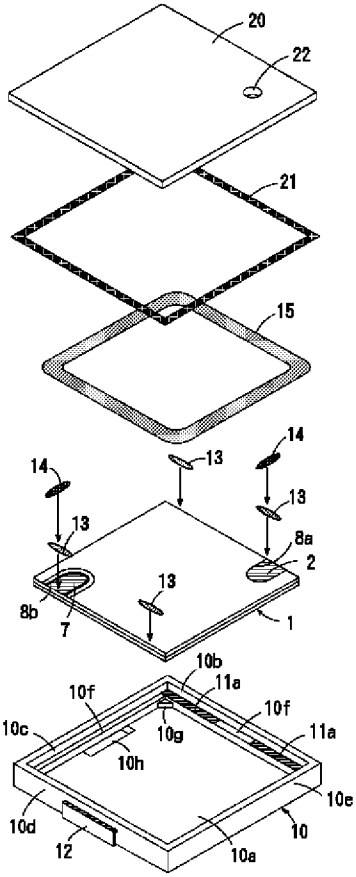
【符号の説明】

１	圧電振動板
１０	ケース
１０ｇ	支持部
１１，１２	端子（端子電極）
１１ａ，１２ａ	内部接続部
１１ｂ，１２ｂ	外部接続部
１４	導電性接着剤
１５	弾性封止剤
２０	蓋板

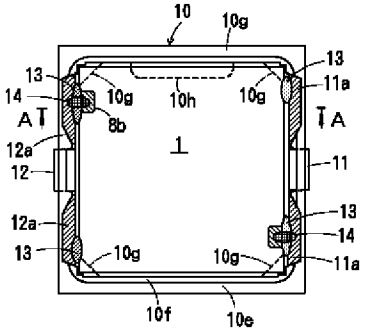
【図１】



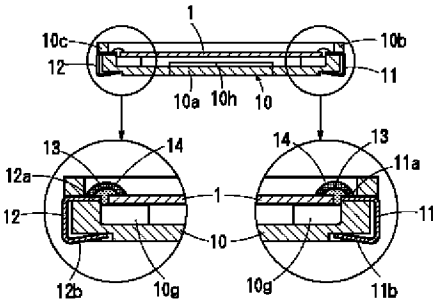
【図２】



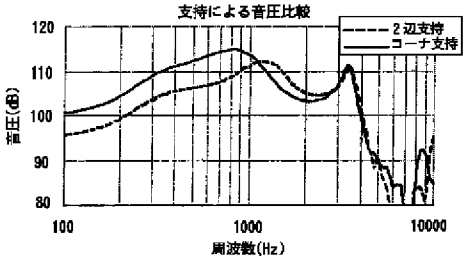
【図３】



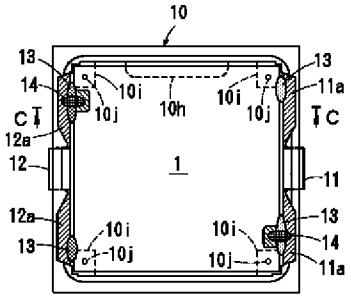
【図４】



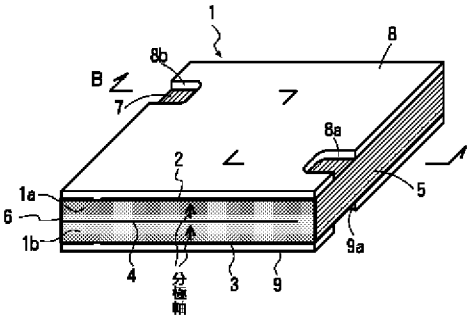
【図７】



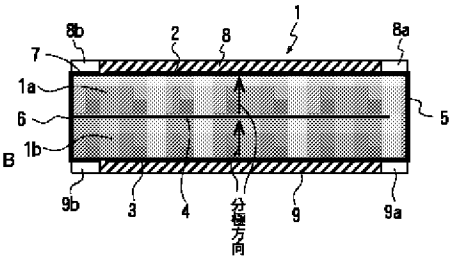
【図８】



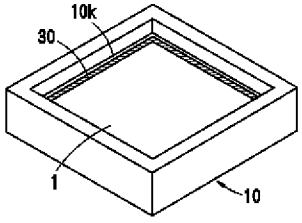
【図５】



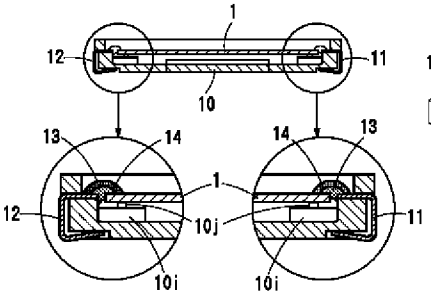
【図６】



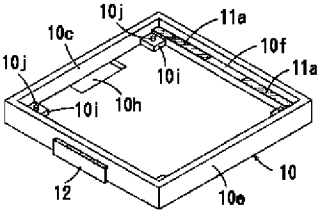
【図１１】



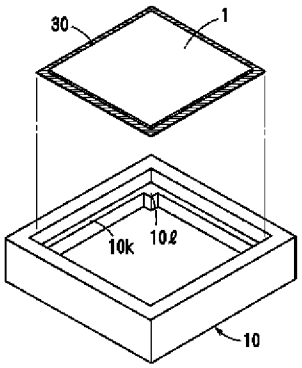
【図９】



【図１０】



【図１２】



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